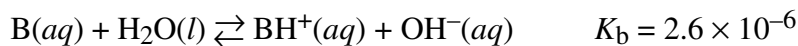


Problem Set 4 (For February 3)

Recommended Text Problems: 7.34, 7.45, 7.55, 7.56, 7.80, 8.18, 8.36

1. The stimulant cocaine is a weak base. It reacts in aqueous solution by a standard hydrolysis reaction and equilibrium constant K_b :



where B is cocaine. What is the pH of a solution of 0.030 mol cocaine solid dissolved in 1.00 L water? If we define the *fraction of cocaine that has reacted with water*, α , to be

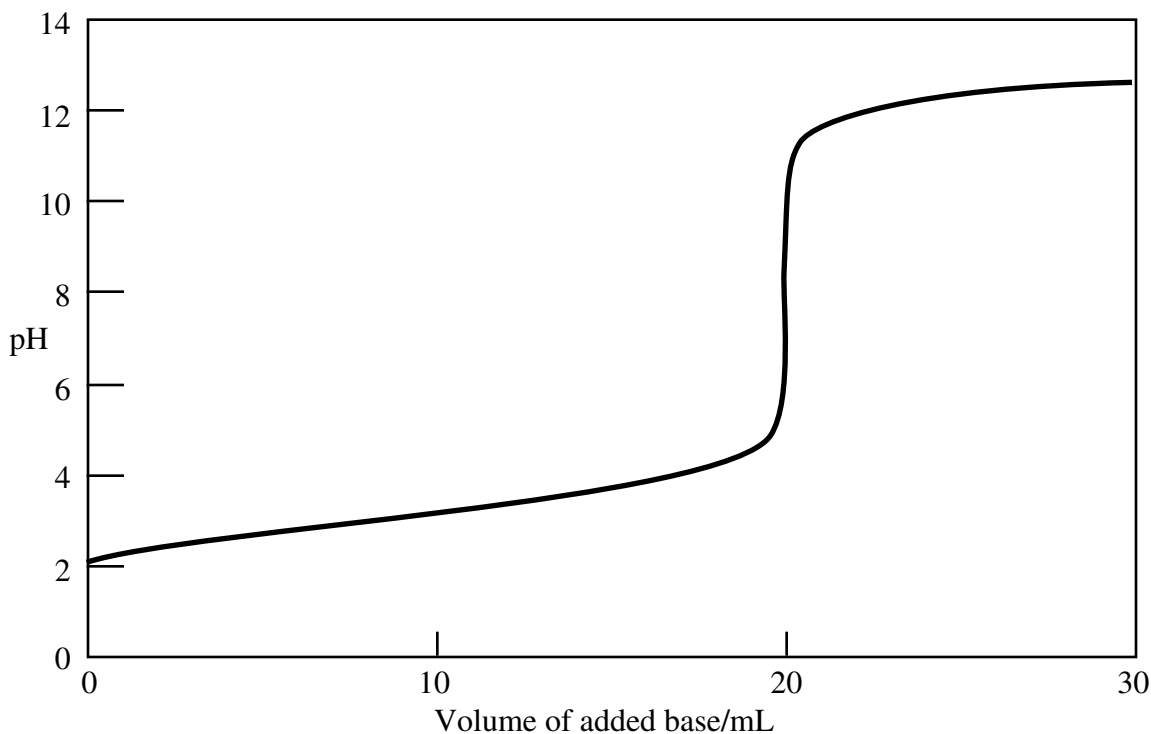
$$\alpha = \frac{[BH^+]}{[BH^+] + [B]}$$

where the concentrations are equilibrium concentrations, what is α for this solution?

2. What is the pH of the buffer solution made by adding 5.74 g $NaC_2H_3O_2$, sodium acetate, 82.03 g mol^{-1} , to 500 mL of 0.05 M CH_3COOH , acetic acid, for which $pK_a = 4.75$? What does the pH become if 50.0 mL of 0.01 M NaOH is added to this solution?

3. The standard acid you'll use in lab, potassium hydrogen phthalate (KHP), is also used to establish a pH reference solution. If 0.05000 mol KHP is dissolved in 1.000 L water, the pH is 4.008. Find the K_a value for KHP to four significant figures from these facts.

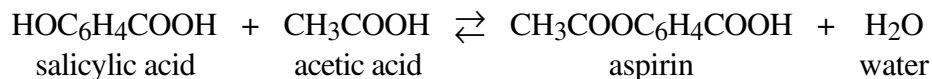
4. Shown below is a titration curve for a titration 100.0 mL of a solution of HF with a standardized 0.500 M solution of NaOH.



What was the solution's concentration? Calculate the initial pH before any base has been added. Calculate the pH *taking into account dilution effects* after 10 mL, 20 mL, and 30 mL of NaOH has been added. Check your answers against the graph!

Problem Set 4 (For February 3)

5. (From a past exam...) A. Beauregard Clump, junior chemist, reads the chemical literature, learns how aspirin is synthesized, and decides to try out the synthesis in his basement lab. He procures himself 6.22 g of salicylic acid (which, with a molecular weight of $138.12 \text{ g mol}^{-1}$ corresponds to 45.0 mmol) and an excess of acetic acid. The synthesis reaction is



(a) The molecular weight of aspirin is $180.16 \text{ g mol}^{-1}$. What is the maximum mass of aspirin Beauregard could synthesize?

(b) Beauregard collected and purified his aspirin product, and he wanted to know how great his yield was. Unfortunately, his large cat had sat on his balance and broken it, but his pH meter was still working. He dissolved all his product in 1.00 L of water and found that the solution had a $\text{pH} = 3.19$. What was his yield, expressed as a percentage of his maximum yield from part (a)? You will also need to know that aspirin's $K_a = 2.75 \times 10^{-5}$.